Equipment Development & Test Report
7160-3

improving FOREST SERVICE OUTDOOR POSTERS

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Forest Service - U. S. Department of Agriculture
Equipment Development Center
Missoula, Montana 59801

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Abstract

The Forest Service has a large outdoor poster program with some 200 poster designs. A survey of Ranger Districts in five Forest Service Regions revealed two major problems: (1) premature poster deterioration—specifically poster boards that absorbed moisture and warped, and ink that faded; and (2) a poster ordering system that involved much paperwork and long delivery times. The Missoula Equipment Development Center (MEDC) embarked on a project to help improve the poster program by finding better base materials and inks and improving the poster ordering and delivery process. After extensive tests, ABS plastic and high-impact polystyrene and two commercial inks, Nazdar 70000 and KC System 2, were found to offer the durability field units needed in outdoor posters. To improve poster ordering, the MEDC staff began work on a new poster catalog. This work was subsequently taken over by the national sign coordinator in the Washington Office, who designed and distributed a new poster catalog.

Keywords: Outdoor posters, base materials, inks, equipment development testing, sign maintenance.

A report on Equipment Development and Test (ED&T) Project 2431–Outdoor Posters, sponsored by the Engineering Staff.

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Introduction

The Forest Service has an extensive outdoor poster program with some 200 poster designs for campground information, boundary markers, fire danger warnings, regulatory notices, and explosives signs for vehicles. The constant demand for these posters contributes over $40,000 a year to printing costs in the Washington Office alone, and Regional Offices spend additional large sums. Administration, warehousing, shipping, posting, and reporting add considerably to costs.

Forest Service posters must be esthetically pleasing, communicate effectively, and be durable enough to withstand exposure to severe weather.

In recent years, field employees have voiced complaints about the weathering qualities of Forest Service posters. They particularly object to poster board absorbing moisture and premature fading of the inks.

In 1974 the Missoula Equipment Development Center (MEDC) was funded to investigate poster problems. As a first step, the Missoula Center surveyed Ranger Districts in the Rocky Mountain, Southwestern, Intermountain, California, and Eastern Regions to identify specific problems encountered in the poster program.

The major problem identified was premature deterioration of poster boards, inks, and paints. Field employees felt posters should be expected to last at least 6 months outdoors. To determine the extent of the weathering problem, the Center tested a number of Forest Service posters in its weatherometer, a machine that simulates weathering on an accelerated basis. The results substantiated field complaints of premature poster failure.

A second problem was poster ordering. Field employees complained about the amount of paperwork involved, long delivery times, and the fact that requested posters sometimes never arrived.

The Center embarked on a project to help improve the poster program. Plans called for:

- Selecting and testing promising new base materials and inks.

- Preparing an easy-to-use poster ordering catalog.

- Sampling delivery of posters from central supply.

This report discusses the results of this project.

Verifying Poster Problems

Outdoor Weathering Tests

To verify field complaints revealed in the survey, outdoor weathering tests were conducted at Tucson, Ariz., and Olympia, Wash., in May 1974 (figs. 1, 2). These locations were picked because they represented diverse climates — Tucson, hot and dry; Olympia, cool and wet — that would subject test posters to extreme conditions.

In Tucson, 57 posters were mounted facing south on a chainlink fence. In Olympia, an equal number of posters were mounted on south-facing vertical plywood mounting boards. Posters representing every size, poster board type, and color combination to be found in the Forest Service poster program were tested. These included the smallest, 11 x 14 inches, to the largest 34 x 42 inches.

Figure 1.--Poster weathering test, Olympia, Wash.

Figure 2.–Poster weathering test, Tucson, Ariz.

In August — after 90 days of outdoor exposure — these posters were taken down and analyzed for deterioration. The weathered posters were compared with unweathered control samples. Ink fade was recorded, and warping, shrinking, and other deterioration was noted. The inks and boards were rated as excellent, little or no deterioration; good, some deterioration, slight fade, but still serviceable; fair, borderline appearance but still communicating a message; poor, unserviceable (table 1).

Table 1.—*Condition of posters after 90-day outdoor weathering test*

	Excellent	Good	Fair	Poor
Tucson				
Ink	15	21	9	12
Poster board	0	19	37	1
Olympia				
Ink	5	26	17	9
Poster board	2	13	37	5

Field Test Results

Lightweight paper poster boards were the most common failure. Many multilayer, paper-base boards had an esthetically displeasing warping. Ink flaking was also evident. This was probably due to expansion and contraction of the board as it alternately absorbed moisture and dried.

Red and yellow inks on several posters faded so badly the posters were useless. Many blues and greens faded badly also, but as a rule held up better than reds and yellows. Black was least affected by weathering. Inks and poster boards weathered with slightly better results in Tucson.

The outdoor weathering test results generally paralleled the weatherometer findings and information received from field people on poster deterioration. Of 21 posters unsatisfactory after 90 simulated days in the MEDC weatherometer, 17 also weathered poorly in the outdoor test. Of the 36 posters that remained in satisfactory condition after 90 simulated days in the weatherometer, 35 were rated excellent to good after 90 days outdoors.

In summary, most of the posters suffered deterioration. The large posters (multilayered paper base) held up better than small posters (single layer paper), probably because of the heavier, more stable board. In fact, many of the lightweight posters deteriorated so badly, MEDC recommended that immediate steps be taken either to eliminate them from the poster program or upgrade the poster board.

Looking for New Poster Materials

Weatherometer Testing of Promising Inks, Paints, and Base Materials

Because of the poor performance of many Forest Service poster boards, weatherometer tests were begun on promising plastic materials and several varieties of waterproofed and water-resistant, paper-base boards not used in Forest Service posters. Eighteen were chosen for weatherometer testing. Materials ranged from the common ply cardboards to the more exotic (and more expensive) spun polyethylene, polystyrenes, acrylonitrile-butadiene-styrene (ABS), and vinyls. They were:

- Kraft 80-pound high wet strength (paper base).
- Bristol 300M weatherproof (paper base).
- PSA vinyl (fluor.) adhesive-orange-red (plastic base).
- PSA vinyl (fluor.) adhesive-chartreuse (plastic base).
- Rainkote (ODB) 0.050-inch waterproof (paper base).
- Texoprint 80-pound plastic-coated (paper base).
- Type 7459 (paper base).
- Type 7466 (paper base).
- Type 7488-B (paper base).
- Rainy-day 0.030-inch (paper base).
- Rigid vinyl 0.010-inch (plastic base).
- Rigid vinyl 0.020-inch (plastic base).
- Polystyrene 0.010-inch, high impact (plastic base).
- Polystyrene 0.015-inch, high impact (plastic base).
- Polystyrene 0.020-inch, high impact (plastic base).
- ABS plastic 0.060-inch (plastic base).
- Tyvek 1058 spun polyethylene (plastic base).
- Corvon 130 uncoated wet strength (paper base).

These 18 base materials were tested with 11 types of ink. Each sample was coated with each ink in the three primary colors (red, yellow, and blue) and black. Combinations of inks and bases produced 792 individual samples for analysis (fig. 3).

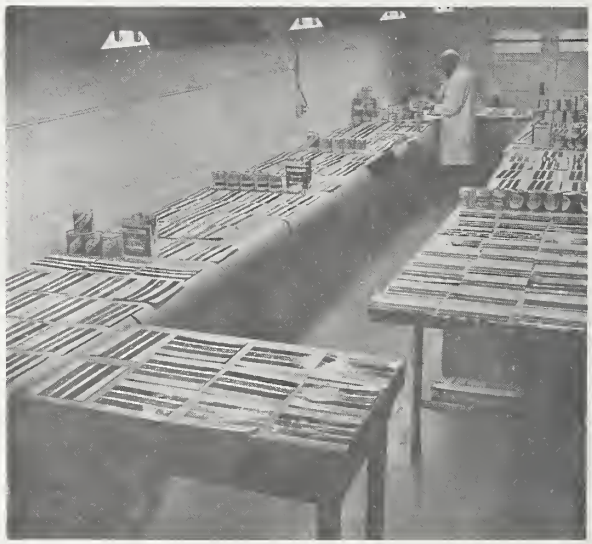

Figure 3.--Preparing samples for weatherometer testing.

The weatherometer tested samples (fig. 4) for 180 hours, equal to 180 days of outdoor exposure. The weatherometer simulated the central portion of the Northern Temperate Zone (ASTM Standards No. D822-60, revised 1970).

The weatherometer was an Atlas model X W-R. It provided continuous automatic control of both temperature and relative humidity and continuously recorded wet and dry bulb temperatures. Carbon arcs burned through Corex D glass filters provided an artificial exposure similar to natural sunlight. The posters were subjected to continuous ultraviolet rays with an intermittent spray of demineralized water at 14 pounds per square inch. The cycle was 102 minutes "dry" followed by 18 minutes "wet," with relative humidity held at 50 percent. Surface temperature was a constant 150° F. An engineering technician rated the samples good, fair, or poor at about 20-hour intervals (equivalent to 20 days of outdoor weathering) during the test.

Figure 4.--Evaluating samples after accelerated weathering in a weatherometer.

Weatherometer Test Results

Base Materials.—In the 180-day weatherometer test, most base materials suffered deterioration. (Test results are summarized in table 2.) Large, multilayered, paper-base posters held up better than small, single layer ones, probably because of the heavier, more stable poster board.

Three bases proved superior:

- 0.060-inch acrylonitril-butadiene-styrene (ABS) plastic.
- 0.020-inch high-impact polystyrene.
- 0.050-inch waterproof Rainkote.

Rainkote was the best of the multilayered paper bases tested. It also is produced in 0.036-inch and 0.070-inch thicknesses.

The ABS plastic and polystyrenes outperformed the paper-base samples by far. Of the two, the ABS plastic was superior.

Table 2.—*Weatherometer test results of base materials after 180 hours (equivalent to 180 days of outdoor exposure)*

Base Material	No. of paint samples		
	Good	Fair	Poor
Kraft 80 lb high wet strength			11
Bristol 300M weatherproof			11
PSA vinyl (fluor.) adhesive-orange-red			11
PSA vinyl (fluor.) adhesive-chartreuse			11
Rainkote (ODB) 0.050 waterproof	2	5	4
Texoprint 80 lb			11
Type 7459, paper base			11
Type 7466, paper base			11
Type 7488-B, paper base			11
Rainy-day 0.030, paper base			11
Rigid vinyl 0.010, plastic base			11
Rigid vinyl 0.020, plastic base			11
Polystyrene 0.010, high impact, plastic base		1	10
Polystyrene 0.015, high impact, plastic base		1	10
Polystyrene 0.020, high impact, plastic base	2	1	8
ABS plastic 0.060, plastic base	9	2	0
Tyvek 1058 spun polyethylene, plastic base		6	5
Corvon 130 uncoated wet strength, paper base		4	7

Inks.—Analysis of the 11 ink samples tested showed two clearly superior:

- KC System 2.
- Nazdar GV 100 series.

The KC System 2 ink was rated good for primary colors and black after 180 days of simulated outdoor weathering. The Nazdar ink performed equally well.

Ronan bulletin enamel had excellent durability. Unfortunately, it is not a typical material for mass producing posters. The fluorescent bulletin enamel weathered poorly and faded badly. Table 3 summarizes complete test findings.

When weatherometer findings were compared with the outdoor test results, several similarities were evident: Black is a standout, fade-resistant color. Reds, yellows, and some blues faded rapidly in the outdoor tests. But the weatherometer showed several inks, including red, yellow, and blue, could withstand at least 180 days of outdoor exposure. The best were KC System 2 screen printing inks and Nazdar GV 100 series ink.

The KC System 2 inks are manufactured by KC Coatings, Inc., 500 Railroad Ave., North Kansas City, Mo. 64116; Nazdar inks are from Nazdar, 1087 North Branch St., Chicago, Ill. 60622.

Table 3.—*Ink and paint weatherometer test results after 180 hours (equivalent to 180 days of outdoor exposure)*

Inks	No. of substrate samples											
	Red			Blue			Yellow			Black		
	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor	Good	Fair	Poor
Wornow process poster ink		8	9		1	16		11	6		10	8
Wornow enamel process ink	11	6			16	2			17	11	6	1
Wornow enamel	2	15			17	1		10	7	7	11	
Ronan bulletin enamel	17			18			12	5		18		
Ronan synthetic process enamel	8	9		1	17		2	15		17	1	
Radiant fluorescent bulletin enamel		2	15	1	12	5		2	15	1	14	3
Bisonite hardcote bulletin enamel	16	1		17	1		8	9		18		
KC System 2 screen printing ink	17			16	2		16	1		16		2
Nazdar process enamel	4	10	3	3	12	3	14	3		12	6	
Nazdar GV 100 series ink	16		1	16	1	1	16		1	17		1
Nazdar process ink		13	4		11	7		8	9	2	12	4

Additional Field Testing

Before making final recommendations on base materials and inks for Forest Service posters, the inks and bases that had performed best in the 180-day weatherometer test were subjected to outdoor testing as well.

Test fences were established at Tucson and Olympia, and Forest Service posters were prepared with these bases and inks.

Printing Test Samples.—The Ojo Caliente Craftsmen Cooperative of Ojo Caliente, N. Mex., a commercial shop specializing in screen printing, was contracted to print the test posters.

The Missoula Center furnished the Rainkote and ABS plastic and high-impact polystyrene and the KC System 2 and Nazdar inks. The Ojo craftsmen made the film positives and screened and rack-dried the posters.

Production problems were encountered with the Nazdar GV 100 series ink. The ink was found to be incompatible with plastic — especially the high-impact polystyrene. Stacking weight caused the ink to adhere to the backs of the posters and upon unstacking, many samples were ruined. This problem was not encountered in the weatherometer testing of this material.

After discussions with Nazdar laboratory personnel concerning the problem, a substitute ink, Nazdar 70000 series, which is compatible with ABS and polystyrene, was printed for field testing. In addition, Nazdar 59000 was recommended for paper-base material and was printed on the Rainkote boards.

Selecting Control Samples.—Three posters printed by the Government Printing Office were chosen from the Forest Service stock to serve as control for the outdoor test (fig. 5). They represented typical sizes and were printed in red and black, the most common Forest Service poster colors. In addition, because earlier tests showed red to be a problem due to excessive fading, it was an ideal color for thorough testing.

P51-30 44" x 16"
Red and black on white

P51-62a – Same as P51-62
Red and black on white 42" x 34"

P64-3 14" x 11"
Red and black on white

Figure 5.--Control posters selected for testing.

Installing Test Fences.—South-facing test fences were constructed in Tucson and Olympia and the control and test posters mounted in both locations in March 1976 (figs. 6, 7). The test was conducted for 180 days, the minimum time a poster should remain serviceable. Tables 4 and 5 list the base material, ink, quantity, and size of each poster tested.

Posters were mounted with heavy-duty 3/8-inch staples. These proved inadequate for the 34 inch x 42 inch posters, especially the 0.036-inch and 0.070-inch Rainkote boards. These boards absorb moisture, expand, and upon drying, shrink, pulling loose from the staples. The posters on 0.060 ABS plastic were simply too heavy and the staples pulled loose. When 8P aluminum twist nails were used to reinstall these posters, no further trouble was experienced.

Figure 6.--Test fence, Olympia, Wash.

Figure 7.--Test fence, Tucson, Ariz.

Table 4.—*Test fence at Tucson, Ariz.*

Substrate	Ink	Quantity	Size (Inches)
0.010 Polystyrene	Nazdar 70000	2	11 x 14
0.020 Polystyrene	Nazdar 70000	3	11 x 14
0.036 Rainkote	Nazdar 59000	6	11 x 14
0.070 Rainkote	Nazdar 59000	4	11 x 14
0.010 Polystyrene	KC System 2	3	16 x 14
0.020 Polystyrene	KC System 2	3	16 x 44
0.036 Rainkote	KC System 2	6	16 x 44
0.070 Rainkote	KC System 2	6	16 x 44
0.040 Polystyrene	KC System 2	2	34 x 42
0.060 ABS Plastic	KC System 2	2	34 x 42
0.060 ABS Plastic	Nazdar 59000	2	34 x 42

Table 5.—*Test fence at Olympia, Wash.*

Substrate	Ink	Quantity	Size (Inches)
0.010 Polystyrene	Nazdar 70000	4	11 x 14
0.020 Polystyrene	Nazdar 70000	3	11 x 14
0.036 Rainkote	Nazdar 59000	6	11 x 14
0.070 Rainkote	Nazdar 59000	6	11 x 14
0.010 Polystyrene	Nazdar 70000	4	11 x 14
0.020 Polystyrene	KC System 2	4	16 x 44
0.036 Rainkote	KC System 2	6	16 x 44
0.070 Rainkote	KC System 2	5	16 x 44
0.040 Polystyrene	Nazdar 70000	2	34 x 42
0.040 Polystyrene	KC System 2	2	34 x 42
0.060 ABS Plastic	Nazdar 70000	3	34 x 42
0.060 ABS Plastic	KC System 2	2	34 x 42

Test Results

After weathering for 180 days, the posters were carefully studied for signs of deterioration, and then brought to the Missoula Center for further analysis. This included evaluating each poster with a reflection densitometer, an instrument used in assigning a numerical rating to the amount of ink fade.

The initial analysis indicated that:

- The 0.060-inch ABS plastic was superior to the Rainkote or polystyrene. But the ABS thickness of 0.060-inch compared to the polystyrene's thicknesses of 0.010, 0.020, and 0.040 gave it an obvious advantage.

- The polystyrenes were esthetically more pleasing than the Rainkote boards, but suffered from ultraviolet degradation and yellowing. The south-facing, 180-day outdoor exposure was a severe ultraviolet degradation test, especially in Tucson. The ultraviolet rays tend to make the polystyrene substrates brittle. The thinnest polystyrene, 0.010-inch, performed marginally, cracking readily when removed from the test fence. But all other polystyrenes were in serviceable condition and would have remained so if left untouched.

- The Rainkote boards had absorbed moisture and were warped. They were less pleasing esthetically than posters of either the polystyrene or ABS plastic.

- KC System 2 and Nazdar 70000 and 59000 series inks were far superior to the inks on the control posters.

Test and control posters were further analyzed with a reflection densitometer. Black is the darkest color and has the highest density reading — usually in the 2.0+ range; middle value colors (such as red, blue, and green) are usually in the 0.80+ range, while light value colors (yellow and orange) are rated lower yet.

By measuring light reflection from control posters and test posters, the amount of fade can be rated numerically. For example, the red ink on the GPO control poster "Closed Fire Hazard" had a reflection densitometer reading of 0.59 before the outdoor testing; after 180 days outdoors at the Tucson test site, it rated 0.54. Readings for the black ink were 2.16 and 1.09. The test poster of 0.036 Rainkote board printed with KC System 2 ink rated 0.88 before testing (red) and 0.87 after; the black 2.05 and 1.45.

Comparison of other control and test posters yielded similar findings that ink on the test posters weathered much better. Figures 8, 9, and 10 compare test posters with control posters.

The analysis of reflection densitometer readings showed that black ink on ABS plastic and polystyrene remained very dense after 180 days of outdoor exposure. The paper-base Rainkote board combined with black did not weather as well. Red Ink performed about the same on all three base materials, although to the eye, the color on plastics appeared richer, with a more glossy finish.

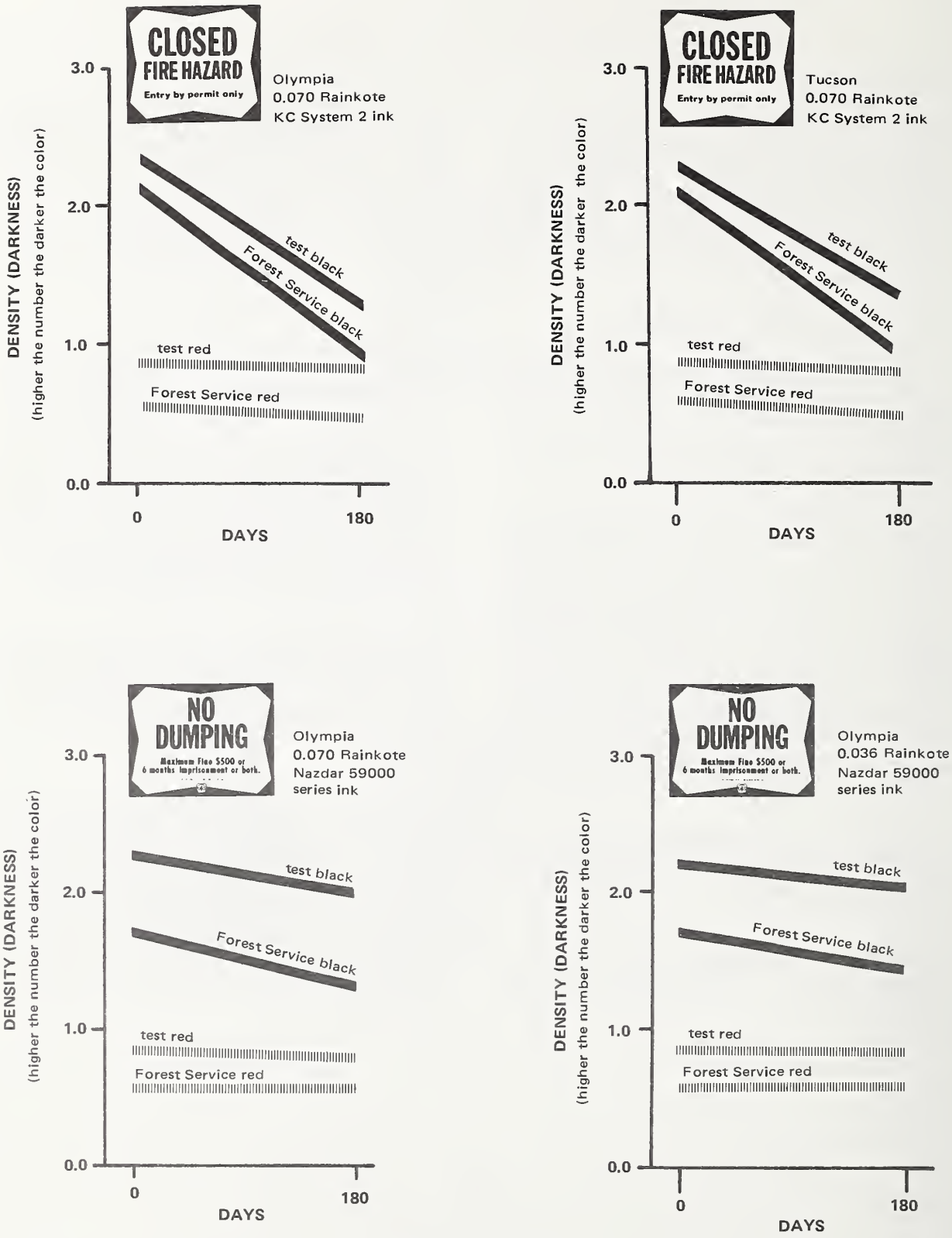

Figure 8.--Reflection densitometer results of paper base Rainkote board combined with test inks compared to present Forest Service posters.

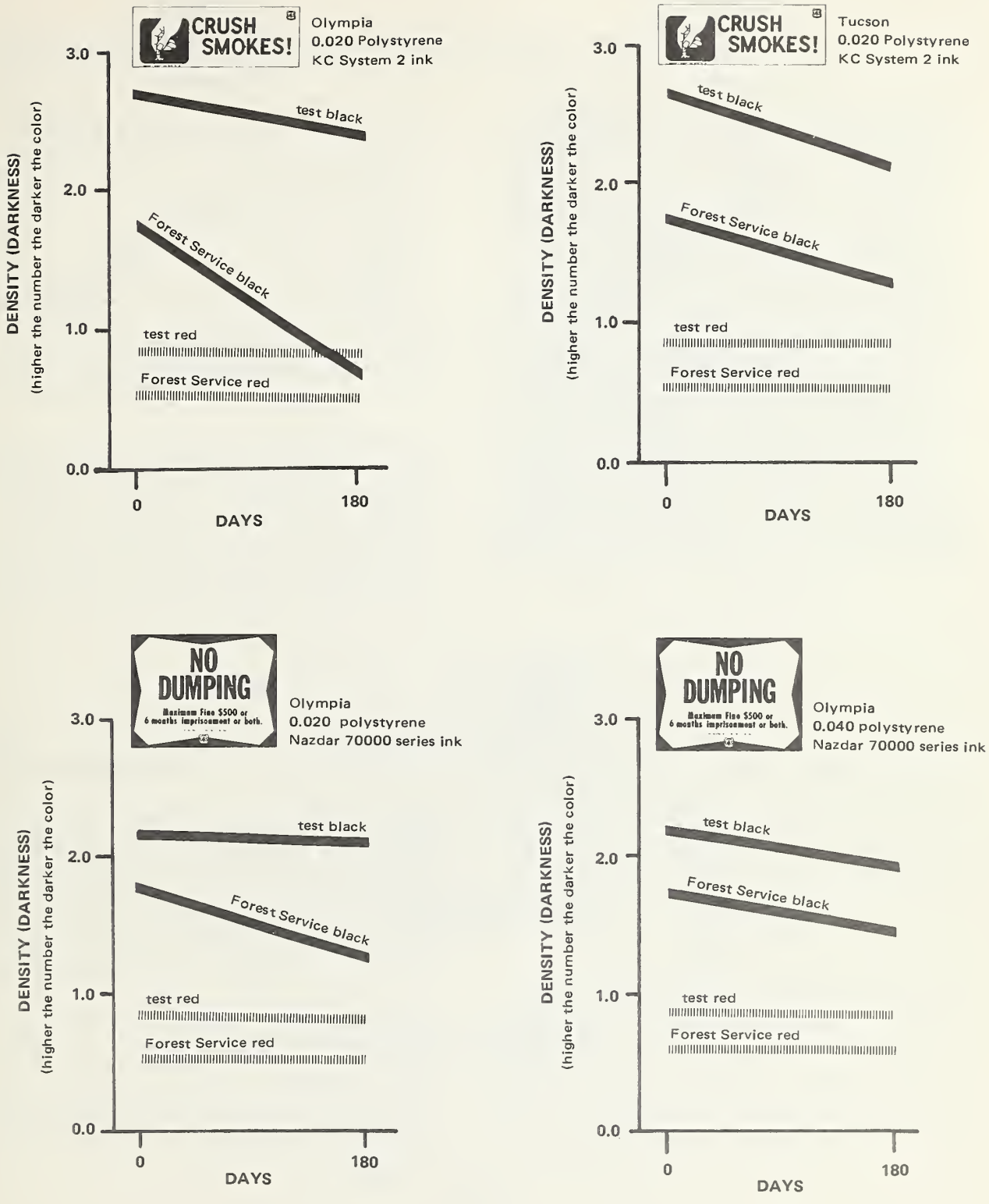

Figure 9.--Reflection densitometer results of high-impact polystyrene combined with test inks compared to present Forest Service posters.

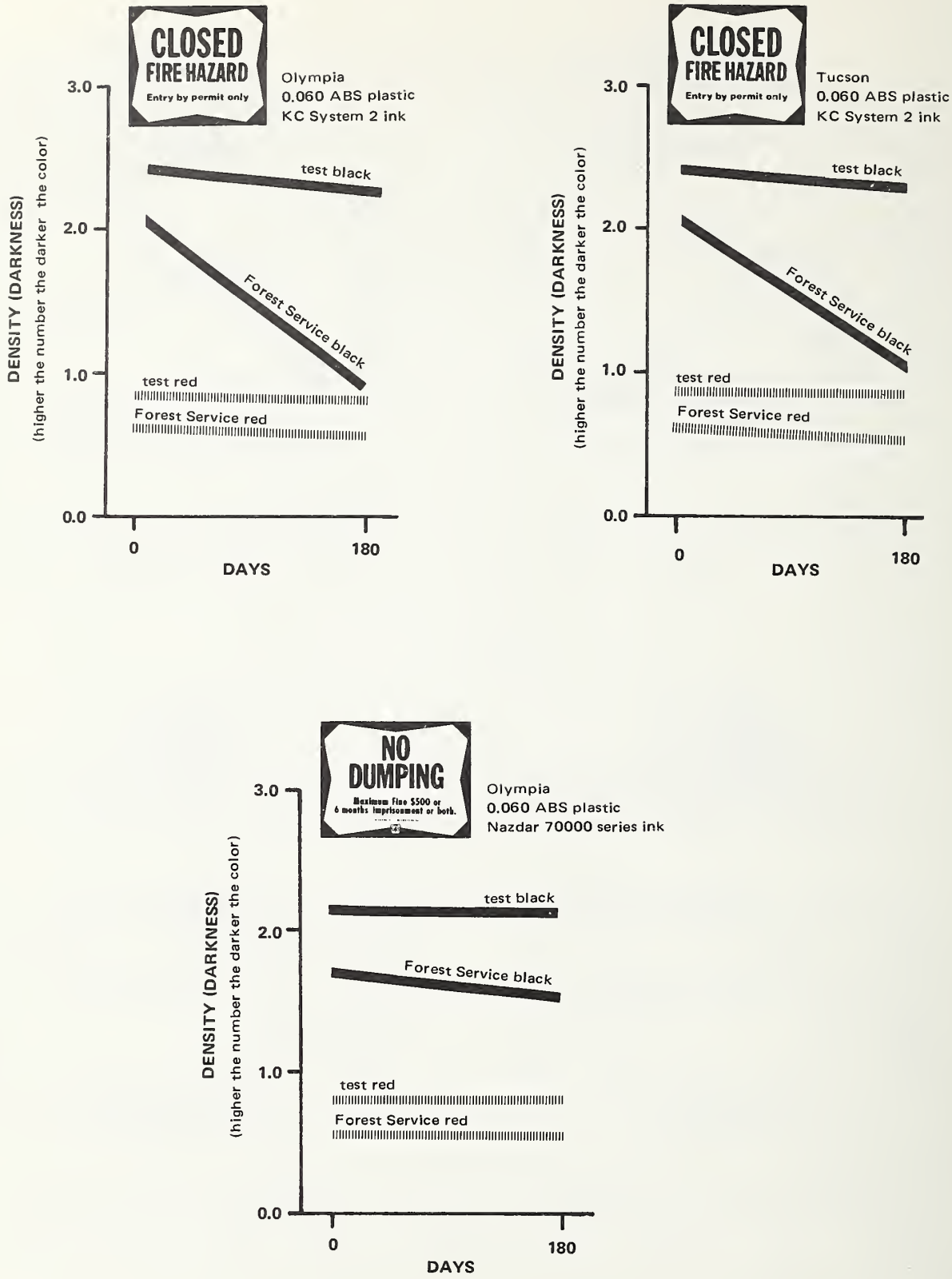

Figure 10.--Reflection densitometer results of 0.060 ABS plastic combined with test inks compared to present Forest Service posters.

Poster Ordering and Delivery

The field survey indicated much dissatisfaction with the process of ordering posters from a cumbersome sign handbook, a 2-inch-thick book with posters found in chapter 80, with ordering procedures found in chapter 13, FSM 4/77 amend. 40, 13.21 FSM 4/77 amend. 40, 13.22 FSH 6/77 amend. 41. The MEDC staff began work on a new poster catalog. This work was taken over by the national sign coordinator in the Washington Office. A streamlined catalog that should aid field employees in ordering posters was subsequently designed, printed, and distributed (fig. 11).

Poster delivery was also a problem, according to field employees. To test the efficiency of the delivery system, MEDC ordered 38 posters of various sizes. Only 13 were received. MEDC then ordered 25 more posters; 6 arrived within 2 months; and 6 more arrived after another month. The remaining 13 were never received.

Figure 11.--Poster ordering catalog.

Discussion

The findings indicate that posters with a service life of 6 months or more can be made from ABS plastic and polystyrene base materials with Nazdar 70000 series and KC System 2 inks. In fact, estimates are that posters of polystyrene generally will last well over 6 months and posters of ABS plastic even longer.

Outdoor and weatherometer testing indicates that the crucial element in poster life is the base material. Any number of inks are marketed that can far outlast paper bases. The recommended Nazdar and KC System 2 inks are examples that proved themselves in these tests.

These inks were found to be compatible with all plastic bases tested; that is, no problems were experienced with them adhering to each base material.[1] Care should be taken to insure compatibility of materials, however, and future specifications for poster printing contracts should insure this compatibility.

The best way to achieve an outdoor poster with a service life of at least 6 months is to use a stable, waterproof base. Plastics are much more stable than paper bases, and their water absorption rate is negligible. Even the best paper-base material tested, 0.070-inch Rainkote, was warped after 6 months outdoors, unacceptable from an esthetic standpoint.

[1]KC Coatings, Inc., recommends KC Jet-plastic 9900 series ink for all polystyrene bases rather than KC System 2 ink. Polystyrene can be manufactured in a variety of formulations, some of which may be incompatible with KC System 2 ink, according to the company. The Nazdar series 70000 ink is compatible with all polystyrene formulations.

There is no doubt that better inks and base materials are marketed than those currently used to produce Forest Service posters. The real question is one of cost. While little difference exists in price between the inks found superior and those used to print Forest Service posters, the plastic bases are more costly (table 6). For example, a typical Forest Service poster of 0.070-inch white poster board costs about 15 cents a square foot. High-impact polystyrene in 0.040-inch thickness costs about 20 cents and 0.060-inch ABS plastic, 60 cents a square foot.

Table 6.—*Prices for outdoor poster base materials and inks.*[1]

Base material	Cost/sq ft
.010 High-Impact Polystyrene	$0.06
.020 High-Impact Polystyrene	0.12
.040 High-Impact Polystyrene	0.20
.036 Beveridge Rainkote	0.10
.070 Beveridge Rainkote	0.15
.020 Polystyrene with ultraviolet inhibitors	0.25
.040 Polystyrene with ultraviolet inhibitors	0.45
.040 Acrylic with ultraviolet inhibitors	0.30
.060 ABS plastic	0.60

Inks	Cost/gal
Nazdar black	$20.00
Nazdar red	25.00
KC System 2 black	20.00
KC System 2 red	29.00

[1]Approximate 1978 prices.

One way to minimize the cost of adopting plastic bases would be to use the most expensive varieties only for the more permanent posters. Many Forest Service posters are in fact permanent signs that have a year-round message (fig. 12). These posters should be identified, and perhaps ABS plastic or the thicker polystyrene (0.040) could be justified in their manufacture.

Other Forest Service posters are of a seasonal or temporary nature (fig. 13). These posters do not require such expensive base materials, and the 0.010 and 0.020 polystyrene may be adequate.

Another cost-saving strategy would be for poster designers to give more consideration to colors that are more fade resistant. Black is the most durable and should be used liberally. Thalo blue, according to Nazdar spokesmen, is a long-lasting color. Other colors should be analyzed for their fade resistance and used accordingly. If fast faders such as red, yellow, and some blues are used, they could be outlined in black to extend poster life.

Field complaints concerning ordering posters from an out-of-date, bulky sign handbook should be alleviated by the streamlined poster catalog.

Poster supply and mailing appear to be a continuing problem. The most recent evidence is contained in a field survey of Forest Service recreation managers, in which they give high priority to receiving signs in a timely manner.[2]

[2]Driessen, Jon. 1978. *Problems in managing forest recreation facilities: a survey of field personnel.* USDA For. Serv. Proj. Rec. 7823 2201, Equip. Dev. Ctr., Missoula, Mont.

Figure 12.–Examples of "permanent" posters with a year-round message.

Figure 13.--Examples of short-term or seasonal posters.

Conclusions

1. The critical element in extending poster life is improving the base material. Many inks can withstand 6 months weathering in a harsh outdoor environment.

2. For posters to maintain an esthetically pleasing appearance for at least 6 months of outdoor exposure, a plastic base should be used.

3. Bases and paints are available that will substantially upgrade Forest Service posters. Sign managers must make a cost/benefit analysis before a decision can be reached on whether to produce posters with these new materials.

4. ABS 0.060 is superior to 0.040, 0.020, 0.010 high-impact polystyrene, and 0.036, 0.070 paper-base Rainkote boards.

5. Nazdar 70000 and 59000 series inks and KC System 2 inks are superior to inks currently used on Forest Service posters. Specifying a long-lasting, fade-resistant ink in poster printing would not substantially increase costs.

6. ABS plastics should be considered for posters that have year-round use.

7. High-impact polystyrene should be considered for posters that are of a seasonal or temporary use.

8. Poster designers should use black extensively to extend poster life.

9. Specifications for poster printing should insure complete compatibility of materials and the use of durable, fade-resistant inks.

10. Delivery is a problem in the poster program. Based on field complaints and MEDC experience in ordering posters, improvement should be made in filling orders and delivering requested posters to the field in a reasonable time.

11. The Forest Service should periodically survey new base materials and inks developed by industry so improved combinations can be systematically introduced into the poster program.

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NATIONAL FOREST SYSTEM
COOPERATIVE FORESTRY
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USDA FOREST SERVICE EQUIPMENT DEVELOPMENT